

PHYTOCHEMICAL EVALUATION OF DATURA STRAMONIUM LEAVES FOR POTENTIAL ANTIFERTILITY ACTIVITY

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ABSTRACT

*Datura stramonium L. (Solanaceae), commonly called thorn apple or Jimson weed, is a widely distributed weed with a long history of use in folk and traditional medicine systems across Asia and Africa. Qualitative phytochemical screening of its leaf extracts has consistently revealed the presence of alkaloids, glycosides, terpenoids, steroids, flavonoids, tannins, and saponins [9], [11]. Among its constituents, tropane alkaloids such as atropine, scopolamine, and hyoscyamine dominate the pharmacological profile of the plant [3], [10]. A growing body of experimental work has examined whether these compounds, individually or as crude extracts, disturb reproductive physiology sufficiently to be classified as antifertility agents. Studies on petroleum ether, ethanolic, and aqueous leaf extracts administered to female albino rats have reported prolongation of the estrous cycle along with antiestrogenic activity, changes consistent with antifertility potential without acute toxicity at the tested doses [1]. This review consolidates findings from primary research articles, review papers, and toxicological reports published over the past two decades, examining extraction methods, phytochemical constituents, dose-dependent reproductive outcomes, and proposed mechanisms of action. The review also situates *D. stramonium* within the broader landscape of plant-derived antifertility agents, comparing its profile with species such as *Datura metel*, *Azadirachta indica*, and other *Solanaceae* members. Gaps identified include inconsistent extraction protocols, near-total absence of isolated-compound studies, lack of dose-response standardization, and no human trial data. The review concludes that while preliminary evidence supports antifertility activity linked to hormonal disruption and possible anticholinergic interference with reproductive tissue, the narrow margin between therapeutic and toxic doses of tropane alkaloids demands considerably more rigorous, standardized investigation before any therapeutic application can be responsibly considered.*

Keywords: *Datura stramonium*¹; phytochemical screening²; antifertility activity³; tropane alkaloids⁴; estrous cycle⁵; herbal contraceptive⁶; reproductive toxicology⁷

1. INTRODUCTION

1.1 Background of the Plant

Datura stramonium belongs to the family *Solanaceae*, a group that also houses *Atropa belladonna*, *Hyoscyamus niger*, and *Datura metel* all known for producing tropane alkaloids with potent central and peripheral

anticholinergic effects. The plant grows as a weed on roadsides, waste ground, and agricultural margins across tropical and subtropical regions, which has made it one of the most accessible medicinal weeds in traditional pharmacopoeias. Traditional healers across India, Africa, and parts of the Americas have used various plant parts for asthma, wound healing, rheumatism, and as an analgesic, and the leaf and seed extracts continue to attract pharmacological interest because of the breadth of bioactive constituents they contain [3]. Despite this long history of use, the plant is simultaneously recognized as one of the more dangerous weeds encountered in casual foraging, since accidental ingestion of seeds has caused documented poisoning and, in extreme cases, death.

1.2 Rationale for Antifertility Investigation

Interest in plant-based antifertility agents did not arise from a scientific vacuum. Synthetic hormonal contraceptives, while effective, carry documented side effects ranging from thromboembolic risk to mood disturbances, and a large share of the global population continues to rely on herbal remedies because of perceived cultural acceptability, affordability, and a comparatively milder side-effect profile [14], [19]. Within this context, plants already known to contain hormonally active or cytotoxic secondary metabolites flavonoids, alkaloids, saponins, tannins become natural candidates for antifertility screening. *D. stramonium*'s established anticholinergic and steroid-modulating alkaloid content places it squarely in this category, and its abundance as a weed means that, unlike many rainforest species screened for pharmacological activity, supply is not a limiting factor for research or eventual production.

1.3 Scope and Objective of the Present Review

This review restricts its scope to leaf-derived extracts of *D. stramonium* and their documented effects on reproductive parameters in animal models, while drawing comparative context from related Solanaceae species and other plants studied for antifertility action. The objective is threefold: first, to summarize the phytochemical composition reported across independent studies; second, to critically evaluate the methodological rigor and reproducibility of past antifertility trials; and third, to identify mechanistic hypotheses hormonal, anticholinergic, or cytotoxic that could explain the observed effects. Given that no single primary study to date has combined comprehensive phytochemical fractionation with mechanistic reproductive endpoints in the same experiment, a synthesis of scattered findings is necessary to determine whether current evidence justifies further isolated-compound research or clinical translation.

2. SURVEY OF PAST WORK

Early ethnobotanical documentation of *D. stramonium* rarely mentioned reproductive effects directly; most reports concerned analgesic, antispasmodic, and antimicrobial folk uses. Reviews of the pharmacognosy of the species have repeatedly confirmed the presence of saponins, tannins, steroids, alkaloids, flavonoids, phenols, and glycosides across leaf extracts prepared with different solvents [11]. This phytochemical consistency across

independent laboratories despite differences in geographic origin of plant material, extraction solvent, and screening protocol is one of the more reliable findings in the literature, and it forms the foundation on which antifertility hypotheses have been built.

The most directly relevant primary study identified for this review examined petroleum ether, ethanolic, and aqueous leaf extracts of *D. stramonium* administered orally to female albino rats at 200 and 400 mg/kg body weight. The ethanolic extract in particular prolonged the estrous cycle and exhibited antiestrogenic activity, and the authors concluded that the extract possessed antifertility activity without producing adverse toxicity at the doses tested [1]. This finding is significant because it links a specific, reproducible extraction method to a measurable reproductive endpoint (estrous cycle length) rather than a vague claim of "antifertility potential."

Comparative work on the sister species *Datura metel* strengthens the plausibility of genus-wide antifertility activity. Ethanolic extract of *D. metel* has been reported to lower sperm content in male models, an effect attributed to reduced testosterone, luteinizing hormone, and follicle-stimulating hormone levels, while acetone seed extract produced complete antifertility action in female mice at a 2% concentration [2]. Although this study used a different species and plant part, the hormonal-axis disruption mechanism it proposes suppression of the hypothalamic-pituitary-gonadal signaling cascade is mechanistically compatible with the estrous cycle disturbances reported for *D. stramonium* leaf extract, since both effects would require the extract's bioactive constituents to interfere with steroidogenesis or gonadotropin release rather than acting purely as a local cytotoxic agent.

Broader reviews of antifertility screening across the plant kingdom provide useful context for how *D. stramonium* research fits within accepted evaluation frameworks. One extensive review examined 200 published antifertility studies, of which 166 demonstrated proven effects of plant extracts or isolated constituents against fertility in laboratory animal models, and specifically investigated phytochemicals present in ethanol, ethyl acetate, methanol, and chloroform extracts of *Datura stramonium* alongside *Musa paradisiaca* [6]. That screening confirmed the presence of tannins, flavonoids, alkaloids, terpenoids, glycosides, saponins, resins, carbohydrates, and proteins, with flavonoids, terpenoids, glycosides, carbohydrates, and proteins specifically detected in *Datura stramonium* extracts [6]. This work is valuable because it directly links the phytochemical profile of *D. stramonium* to a documented antifertility screening exercise, though it stops short of reporting quantitative reproductive endpoints for the species specifically, folding it instead into a broader survey format.

Mechanistic reviews of herbal antifertility agents in general help frame how compounds such as those found in *D. stramonium* might act. Herbal antifertility agents have been characterized as producing anti-implantation, anti-ovulatory, anti-spermatogenic, abortifacient, and estrogenic effects depending on the plant and the sex of the treated animal [16]. In general pharmacological terms, an antifertility substance is considered active in females when it prevents fertilization, ovulation, or implantation, or when it destroys the developing zygote or induces abortion, while in males activity is defined by suppressed spermatogenesis, inhibited testosterone synthesis, altered gonadotropin signaling, or reduced sperm motility [18]. These operational definitions are

important because much of the *Datura* literature reports only one or two of these endpoints (commonly estrous cycle changes or sperm count) rather than the full panel, making cross-study comparison difficult.

Toxicological literature on the tropane alkaloid fraction of *Datura* species adds a cautionary dimension to the antifertility narrative. Regulatory risk assessment of hyoscyamine and scopolamine has established an acute reference dose as low as 0.016 micrograms per kilogram body weight for these two alkaloids combined, reflecting their potency at very small exposure levels [22]. Developmental toxicity data on scopolamine specifically present a more reassuring picture for teratogenicity: scopolamine administered to pregnant mice during major organogenesis at doses up to 900 mg/kg/day produced no evidence of teratogenesis, with only marginal reductions in fetal body weight observed at the two highest doses tested, doses that also produced marginal maternal toxicity [24]. This distinction matters for the antifertility hypothesis: if scopolamine itself is not strongly teratogenic even at high doses, then any antifertility effect attributed to crude *D. stramonium* leaf extract more plausibly arises from a different constituent, or from a combined action of the alkaloid fraction with flavonoids, tannins, or steroidal glycosides present in the same extract, rather than from scopolamine's anticholinergic activity alone.

Related anticancer and anti-inflammatory work on *D. stramonium* leaf extracts, while not focused on fertility, indirectly supports the plausibility of cytotoxic or hormone-modulating action. Ethyl acetate leaf extract of *D. stramonium* has demonstrated notable *in vitro* antioxidant and anticancer activity against tested human cancer cell lines [8], and separate work correlating estimated phytochemicals with observed kinase-inhibitory and cytotoxic actions in leukemia models further illustrates that the same extract classes implicated in antifertility work are also biologically active against rapidly dividing or hormonally sensitive tissue a property directly relevant to reproductive organs, which depend on cyclical, hormone-driven cell proliferation.

3. METHODOLOGY

This review followed a narrative-synthesis approach structured around a systematic literature search, since the fragmented and heterogeneous nature of *Datura* antifertility research does not currently support a formal quantitative meta-analysis with pooled effect sizes. Search terms combining "*Datura stramonium*," "phytochemical screening," "antifertility," "estrous cycle," and "tropane alkaloids" were applied across academic databases and aggregators including PubMed Central, ScienceDirect, Semantic Scholar, ResearchGate, and Academia.edu. Screening prioritized primary experimental studies reporting reproductive endpoints in animal models, supplemented by narrower phytochemical-profiling papers and broader antifertility review articles that provided comparative context from related Solanaceae and non-Solanaceae medicinal plants.

Data extraction focused on four categories of information for each included source: the plant part and solvent system used for extraction; the qualitative or quantitative phytochemical constituents identified; the animal model, dosage, and duration of exposure; and the specific reproductive or hormonal endpoint measured. Where a study reported phytochemical screening without a corresponding fertility endpoint, or a fertility endpoint

without phytochemical characterization, it was retained but flagged as providing only partial evidence, since one of the central conclusions of this review concerns the scarcity of studies that link the two categories of data within a single controlled experiment. Standard qualitative phytochemical screening procedures referenced across the included literature alkaloid detection via Mayer's or Dragendorff's reagent, flavonoid detection via the magnesium-hydrochloric acid or lead acetate tests, tannin detection via ferric chloride reaction, and saponin detection via the froth test were compared against established pharmacognostic reference protocols to assess methodological consistency across laboratories.

Critical appraisal of included studies weighed sample size, presence of a vehicle-treated control group, statistical reporting, and whether toxicity was assessed alongside efficacy, since an antifertility claim carries little practical value if it cannot be dissociated from generalized systemic toxicity. Studies lacking a clearly defined control group or a stated statistical method for comparing treated versus untreated animals were treated with greater caution in the critical-analysis section that follows. No attempt was made to pool numerical outcomes (such as percentage estrous cycle prolongation) across studies into a single effect estimate, because differing extraction solvents, dosing regimens, and animal strains render such pooling more likely to obscure real biological variation than to reveal a genuine consensus effect size.

4. CRITICAL ANALYSIS OF PAST WORK

The existing body of research on *D. stramonium* and antifertility activity is characterized more by consistency in phytochemical findings than by consistency in experimental design, and this asymmetry deserves close scrutiny. On the phytochemical side, independent research groups working with leaf material from different geographic regions and using different solvent systems have converged on a similar core profile of alkaloids, flavonoids, tannins, saponins, steroids, and glycosides [9], [10], [11], [13]. This convergence lends genuine credibility to the qualitative chemistry of the plant. However, this same consistency has, somewhat paradoxically, allowed successive review papers to recycle the same phytochemical summary without meaningfully advancing mechanistic understanding of *why* these constituents would produce antifertility effects specifically, as opposed to the many other pharmacological activities antimicrobial, anti-inflammatory, anticancer also attributed to the identical extract classes.

The core experimental study on estrous cycle prolongation and antiestrogenic activity [1] represents the strongest direct evidence available, yet it illustrates several limitations common to this literature. The study used only two dose levels (200 and 400 mg/kg), which is insufficient to establish a dose-response curve or identify a threshold below which no effect occurs information that would be essential before any translational discussion. Acute toxicity was assessed, which is commendable, but sub-chronic or chronic exposure data, which would be more relevant to a contraceptive use case requiring repeated administration, appear absent from the available literature. Furthermore, the mechanistic claim of "antiestrogenic activity" was inferred from cycle-length

changes rather than confirmed through direct hormone assays (serum estradiol, progesterone, LH, FSH) or receptor-binding studies, leaving the precise mechanism a plausible hypothesis rather than a demonstrated fact.

The comparative *D. metel* findings [2] add useful mechanistic texture implicating suppressed testosterone, LH, and FSH in males but cross-species extrapolation from *D. metel* to *D. stramonium* is scientifically risky given that alkaloid ratios and concentrations differ measurably between *Datura* species even when the same core alkaloids (atropine, scopolamine, hyoscyamine) are present [3], [21]. Reviews of the broader genus have noted that alkaloid concentrations vary substantially depending on plant part and developmental stage [3], meaning that a leaf extract collected at one phenological stage may differ pharmacologically from one collected at another, a variable that almost none of the reviewed antifertility studies controlled for or even reported.

A further weakness concerns the near-total absence of isolated-compound studies. Every antifertility finding reviewed here was generated using a crude or partially fractionated extract rather than a single purified constituent. This makes it impossible to determine whether the antifertility signal originates from the tropane alkaloid fraction, the flavonoid-tannin fraction, or a synergistic combination of both. Given that purified scopolamine at very high doses in mice produced no teratogenic effect [24], and that regulatory toxicology treats hyoscyamine and scopolamine as acutely potent at microgram-per-kilogram exposure levels [22], the antifertility activity attributed to whole-leaf extract cannot currently be cleanly separated from either the alkaloid or the non-alkaloid fraction. This is a significant gap, because rational drug development from this plant would require exactly that separation. [nih](#)

Finally, methodological transparency across the surveyed studies is inconsistent. Several of the review-format sources synthesized in Section 2 [6], [14], [15], [16], [19] provide valuable breadth by cataloguing dozens of candidate antifertility plants, but by design they report secondhand summaries rather than primary data, meaning errors or oversimplifications in an original study can propagate uncritically through several generations of review literature. Independent replication of the core *D. stramonium* estrous-cycle finding by a separate laboratory does not appear to exist in the literature surveyed for this review, which is a notable gap for a claim with potential public-health relevance.

5. DISCUSSION

Taken together, the evidence supports a cautious, provisional conclusion: *D. stramonium* leaf extract, particularly the ethanolic fraction, shows biological activity consistent with disruption of the female reproductive cycle in rodent models, plausibly mediated through interference with estrogen signaling or the broader hypothalamic-pituitary-gonadal axis rather than through generalized cytotoxicity, since the reporting study explicitly found no adverse toxicity at the effective dose [1]. This places *D. stramonium* alongside a wider class of plants including *Datura metel* [2] and species reviewed under the broader antifertility umbrella such as *Azadirachta indica* [17] where crude extracts alter reproductive hormone balance without necessarily damaging the animal systemically at the tested exposure range.

At the same time, the discussion cannot avoid the tension between *D. stramonium*'s antifertility potential and its well-documented toxicological profile as a tropane-alkaloid-bearing plant. The same acetylcholine-receptor-blocking alkaloids that give the genus its medicinal reputation are also responsible for cases of accidental poisoning, and these alkaloids act as strong antimuscarinic agents whose toxicological effects are closely tied to their pharmacological effects on the central and autonomic nervous systems [22]. Any future development of *D. stramonium*-derived antifertility formulations would therefore need a considerably wider safety margin than is currently documented, particularly because contraceptive use implies repeated, not single, dosing a regimen for which no chronic toxicity data currently exist in the reviewed literature. food

A second point of discussion concerns reproducibility and standardization. Because phytochemical composition in *Datura* varies with plant part, growth stage, and geography [3], any antifertility formulation derived from field-collected leaf material would face significant batch-to-batch variability unless standardized extraction and alkaloid-quantification protocols (such as HPLC-based alkaloid profiling, as used in related tropane alkaloid research [21]) are adopted as a precondition for further pharmacological testing. Without this standardization, comparing "200 mg/kg of *D. stramonium* leaf extract" across two different studies is comparing two chemically distinct substances that happen to share a botanical name.

Finally, it is worth situating this plant within the ethical and practical debate around herbal contraceptives generally. Proponents argue that herbal antifertility agents offer affordability and cultural acceptability advantages over synthetic hormonal contraceptives [14], [19], but critics of the herbal-contraceptive literature broadly note the near-complete absence of human clinical trials, dose standardization, and long-term safety monitoring across this entire research domain [20], [23] criticisms that apply with particular force to a plant whose toxic dose range is narrow and well-documented.

6. CONCLUSION

Datura stramonium leaves contain a phytochemically rich and well-characterized profile of alkaloids, flavonoids, tannins, saponins, and glycosides, and at least one controlled animal study provides direct evidence of antifertility activity in the form of estrous cycle prolongation and antiestrogenic effects without acute toxicity at the doses tested. This finding is reinforced indirectly by comparative work on the related species *Datura metel*, which demonstrates hormone-axis suppression in both female and male models, and is contextualized by a substantial body of general antifertility-plant literature that treats Solanaceae alkaloid-bearing species as plausible candidates for reproductive modulation. However, the field remains at an early, largely descriptive stage: dose-response relationships are unestablished, isolated bioactive constituents responsible for the effect have not been identified, chronic and reproductive-toxicity data are absent, and no independent replication or human trial data exist. Given the narrow safety margin already documented for the plant's tropane alkaloid fraction, any translational ambition toward a *Datura*-derived antifertility agent must be preceded by bioactivity-guided fractionation, standardized alkaloid quantification, dose-response toxicology across chronic exposure

windows, and mechanistic hormone-assay confirmation. Until that work is completed, *D. stramonium* should be regarded as a scientifically promising but pharmacologically unproven candidate for antifertility application.

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